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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ANTAGONISM AND PERMEABILITY[1]

BY antagonism we mean that one toxic substance acts as an antidote to another. A solution containing salts in the proper proportions may have none of the toxic action of the individual salts. Such a mixture has been called by Loeb a physiologically balanced solution. It is found that physiological balance is of the greatest importance not only for marine organisms, but also for fresh-water and terrestrial plants and animals: these considerations have found practical application in agriculture.

In the hope of throwing light on the cause of antagonism the speaker made experiments on the penetration of salts into the cell. It was found that while NaCl alone penetrated rapidly the addition of a little $CaCl_2$ delayed penetration. It therefore seemed as though calcium antagonized sodium by preventing more or less completely its entrance into the cell. This idea had been suggested by Loeb but had not received experimental support.

These experiments (which included a number of salts) were carried out by means of the method of plasmolysis. This method did not yield quantitative data of the desired precision, but it was found possible to obtain much more accurate results by the method of electrical conductivity. By this method we measure the resistance offered by protoplasm to the passage of ions. In sodium chloride the resistance rapidly diminishes until it becomes stationary: this means that in NaCl the permeability of the protoplasm rapidly increases until death occurs,

[1] Address delivered before Section G, American Association for the Advancement of Science, at a symposium, December 27, 1916.

after which it remains fixed. In $CaCl_2$ the permeability at first decreases until a certain minimum is reached: after this it begins to increase and finally reaches a constant value (as in NaCl), which signifies death.

Further experiments showed that all substances which affect permeability may be divided into two groups, (1) those which act like NaCl; (2) those which act like $CaCl_2$. This led to the following hypothesis: Substances of the first group antagonize substances of the second group and vice versa.

Experiments were then made to test this hypothesis. It was found that substances which behave like NaCl with respect to antagonism (in experiments on growth) behave like NaCl in their effect on permeability. Substances which behave like $CaCl_2$ with respect to antagonism also behave like $CaCl_2$ in their effect on permeability. Moreover, substances like $LaCl_3$, which antagonize NaCl more powerfully than does $CaCl_2$, are found to affect permeability more powerfully than $CaCl_2$. There is therefore a striking parallel between effects on permeability and the antagonistic effects observed in experiments in which growth and length of life are employed as criteria of antagonism.

Equally remarkable is the outcome when permeability is used as the criterion of antagonism. It is found that all solutions which permit normal growth are likewise solutions which preserve normal permeability.

These experiments which were originally made on *Laminaria* were afterward extended to other algæ, to flowering plants and to animals.

Using permeability as a criterion of antagonism, the speaker has made investigations on a great variety of substances. Time is lacking to describe these, but it may be said that the outcome in every case has supported the hypothesis. This was strikingly shown in investigations on organic substances (non-electrolytes), a number of which were found to belong to the second group. It turned out that all of these substances were able to antagonize NaCl, as is required by the hypothesis.

This result greatly strengthened the speaker's confidence in the hypothesis which seems to serve a useful purpose by enabling us to predict what substances will antagonize each other.

As the result of these investigations we seem to be justified in concluding that there is a close connection between antagonism and permeability. Conclusions concerning such fundamental relations should be tested, whenever possible, by a variety of methods. This task was undertaken by Dr. Brooks, who confined himself chiefly to the following methods: (1) diffusion through living tissue, (2) exosmosis, (3) change of curvature of strips of tissue.[2]

In the first of these methods different solutions were placed on opposite sides of a piece of tissue. The diffusion of salts through the tissue was then measured.

In the second method the tissue was placed for a short time in a salt solution and the rate at which substances subsequently diffused out of the cell was measured.

In the third method strips of the peduncle of the dandelion were placed in hypertonic salt solutions and the rate of penetration of the salt into the protoplasm was calculated from the rate at which the strips recovered their normal shape after being curved by the action of the hypertonic solution (the strips remaining in the solution during recovery). This gives the same kind of information as plasmolysis but avoids the most serious errors of that method.

[2] Brooks, S. C., *Proc. Nat. Acad.*, 2: 569, 1916.

It is a very striking fact that all three of these methods agree with those already described in showing that physiologically balanced solutions preserve normal permeability, while NaCl causes a rapid increase, and $CaCl_2$ an initial decrease, followed by an increase of permeability.

This general agreement can not but increase our confidence in the conclusion that permeability and antagonism are intimately connected.

Further studies have shown that permeability serves as a delicate indicator of what we may call the vitality of the organism. By this is meant a condition of normal health and vigor and the ability to resist unfavorable influences. An organism which has normal permeability (as shown by determining its electrical conductivity) behaves normally in all respects and lives a normal length of time under laboratory conditions, while one which has abnormally high permeability behaves abnormally and does not live the normal length of time. Hence it would appear that we can treat vitality quantitatively, for if the vitality of a large number of organisms is measured in this way we obtain a variation curve: this indicates that vitality may be treated in the same manner as any other character (as, for example, length or weight).

Moreover, since increase of permeability indicates injury, we have a method of measuring injury and of distinguishing quantitatively between temporary and permanent injury. It is found that great fluctuations of permeability are possible without permanent injury. These fluctuations may control the metabolism of the cell.

These studies show that all agencies which sufficiently alter the normal permeability of the protoplasm (such as poisons, excessive light, heat, electric shock, severe plasmolysis, mechanical shock, partial drying, lack of oxygen, etc.), shorten the life of the organism. This is a very striking fact and its significance seems to be unmistakable. It indicates that permeability is a delicate and accurate indicator of vitality.

An analysis of the factors which control permeability has been attempted in subsequent studies. The changes in the resistance of tissues placed in mixtures of NaCl and $CaCl_2$ have been carefully determined. These are shown in Fig. 1. A glance at the figure suggests that there are two processes, one of which causes a rise, the other a fall of resistance. It is natural to suppose that these are chemical in nature and we may assume that they are consecutive reactions by which a substance M, which determines the resistance of the protoplasm, is formed and broken down according to the formula

$$A \rightarrow M \rightarrow B.$$

It may be assumed that M is a substance at the surface of the cell which offers resistance to the passage of ions.

It is evident that if the first reaction $A \rightarrow M$ is more rapid than the second, M will be formed more rapidly than it is decomposed and will increase in amount. Eventually, as the supply of A becomes exhausted, the formation of M will go on more and more slowly, so that it will no longer keep pace with the decomposition. The amount of M will then diminish until it finally disappears or reaches a fixed minimum (this corresponds to the death of the tissue). It is evident that if the relative velocities of the two reactions $A \rightarrow M$, and $M \rightarrow B$ be properly varied the curves of resistance will rise and fall rapidly or slowly in the manner shown in Fig. 1. It can be shown that these assumptions enable us to account for all the experimental curves.

A point of importance is that the veloci-

ties of both reactions reach a minimum in a definite mixture of $NaCl + CaCl_2$. This mixture contains the molecular proportions 95.24 $NaCl$ + 4.76 $CaCl_2$. We can account for this if we suppose that both the reactions are inhibited by an organic salt[3] formed with a constituent X of the protoplasm according to the equation

$$2NaCl + X + CaCl_2 = Na_2XCaCl_4.$$

We may also assume that the reaction $A \rightarrow M$ is catalyzed by $CaCl_2$. This enables us to account for the fact (which is clearly evident from an inspection of the curves) that the greater the proportion of $CaCl_2$ in the mixture the higher and more rapidly the curve rises.

[3] The amount of this salt will be greatest in the mixture of 95.24 $NaCl$ + 4.76 $CaCl_2$ if the reaction takes place in the surface and $CaCl_2$ is 10 times as concentrated in the surface as $NaCl$.

The extent to which these assumptions enable us to predict the behavior of the tissues in various mixtures is evident from Table I.

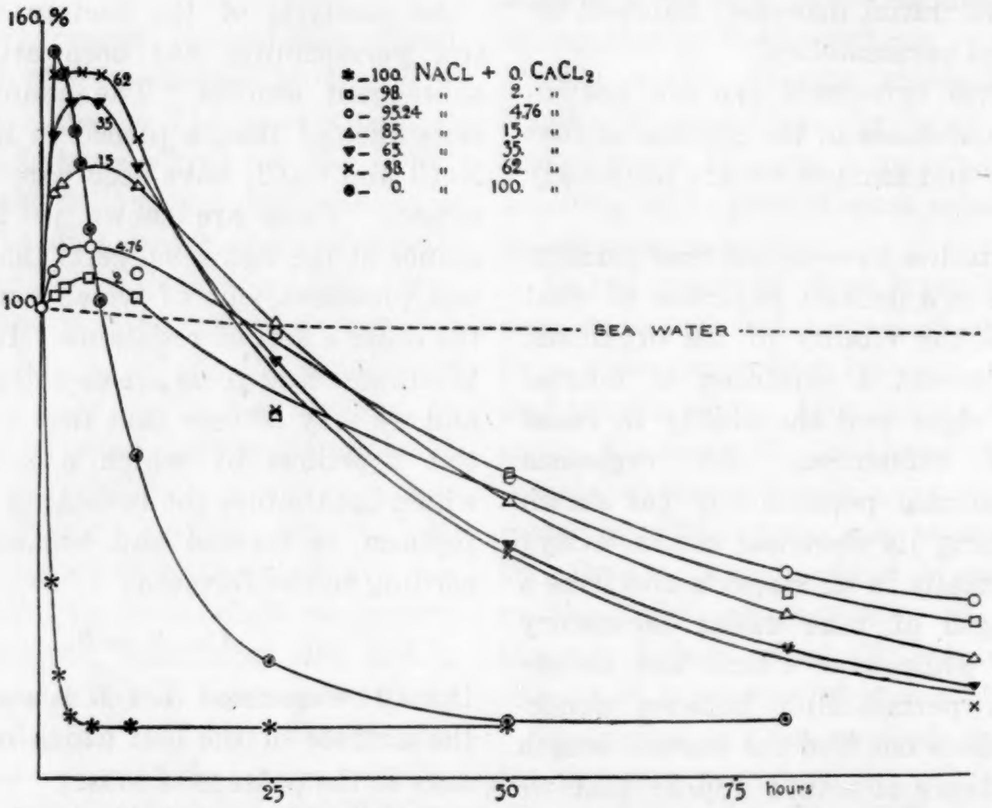

FIG. 1. Curves of electrical resistance of *Laminaria* in $NaCl$ .52*M*, in $CaCl_2$ .278*M*, and in mixtures of these (the figures show the molecular per cent. of $CaCl_2$ in the mixture).

It is evident that the agreement between observed and calculated values is remarkably satisfactory. In regard to the theoretical procedure it should be said that in constructing equations for the curves the minimum number of constants has been employed and the attempt has been made to proceed with the fewest and the most natural assumptions. These assumptions appear to be very reasonable, for it is evident that there must be two processes in order to produce a rise and fall of resistance and that their speed must be regulated by $NaCl$ and $CaCl_2$. It is also apparent that these salts must enter into some sort of combination with a constituent of the protoplasm and it is evident that this compound may regulate the speed of these processes.

We thus arrive at an explanation of antagonism. The theory[4] attempts to account for the following facts.

1. Why both NaCl and $CaCl_2$ are toxic.

TABLE I

Observed and Calculated Values of Resistance of Laminaria in Mixtures of NaCl and $CaCl_2$

Time in Hours	Per Cent. of Net Resistance in									
	98 NaCl + 2 $CaCl_2$		95.24 NaCl+4.76 $NaCl_2$		85 NaCl + 15 $CaCl_2$		65 NaCl + 35 $CaCl_2$		38 NaCl + 62 $CaCl_2$	
	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
1	103.1	103.7	108.2	106.8	124.5	115.6	136.1	123.8	148.1	127.2
2	103.8	105.8	112.1	111.2	126.1	124.8	141.9	136.3	149.0	141.7
3	105.8	106.7	112.1	113.8	128.5	129.8	143.2	142.2	149.0	148.0
4	106.1	106.9	113.9	115.3	130.2	132.1	143.9	144.0	149.0	149.7
5	106.1	106.6	113.1	115.8	130.2	132.7	143.9	143.6	149.0	148.8
6	104.9	106.0	113.1	115.8	130.2	132.3	143.7	141.7	149.0	146.5
10	102.1	101.8	107.9	112.5	126.5	125.1	129.5	129.8	136.1	132.6
25	76.89	84.21	95.21	93.41	96.40	93.80	87.85	87.90	78.21	86.30
50	63.90	61.70	62.50	68.20	58.11	58.83	47.81	47.80	46.34	44.46
80	38.90	43.49	42.52	47.78	33.92	35.54	26.01	25.88	27.11	23.27
100	31.80	35.09	35.83	38.33	24.01	26.58	17.33	18.90	14.42	17.03

The measurements were made at 15° C. or corrected to this figure. Each experimental figure is the average obtained from 6 series of experiments.

All the mixtures had the same conductivity as sea water.

2. Why when mixed in the proper proportions their toxicity is greatly diminished (antagonistic action).

3. Why they have opposite effects on permeability.

4. Why the decrease of permeability produced by $CaCl_2$ must be followed by an increase when the exposure is sufficiently prolonged.

5. Why all toxicity disappears in sea water. This is accounted for by supposing that in sea water A is formed as fast as it decomposes.

The theory gives a quantitative explanation of the toxicity of all the mixtures and enables us to predict the resistance (and permeability) in any mixture at any moment during exposure.

It likewise emphasizes the fact that life processes consist largely of consecutive reactions and that analysis of the dynamics of such reactions is indispensable for the solution of certain fundamental problems of biology.

Reference has been made to the suggestion that calcium antagonizes sodium by preventing it from entering the cell. This explanation encounters a difficulty in the fact that even in a balanced solution the salts penetrate the cell. This difficulty disappears if we adopt the point of view which has just been presented, for it is evident that on this basis we do not regard antagonism as due to prevention of penetration. Nor is there any reason to suppose that the penetration of salts will have an unfavorable effect provided that as they penetrate into the cell the balance between them is preserved.

There is another aspect of the subject which is of considerable interest. It is usually found that when antagonistic substances are mixed in various combinations there is one proportion which is more favorable than others. If we increase the concentration of one constituent it is necessary to increase the concentrations of the others in like proportion in order to preserve the optimum condition. This law of

[4] *Cf. Proc. Am. Phil. Soc.*, 55: 533, 1916.

direct proportionality has been identified with Weber's law by Loeb, who says:

Since this law underlies many phenomena of stimulation it appears possible that changes in the concentration of antagonistic ions or salts are the means by which these stimulations may be brought about.

In view of the importance of these relations it seems desirable to ascertain what mechanism makes one proportion better than others and preserves this preeminence in spite of changes in concentration.

Precisely this kind of mechanism is involved in the theory just outlined. It is easy to see that such a mechanism must exist if the formation of Na_2XCaCl_4 takes place at a surface. In a surface substances usually exist in a different concentration from that which they have elsewhere in the solution. If NaCl and $CaCl_2$ migrate into the surface, so as to become more concentrated there than in the rest of the solution, their concentration in the surface must increase, as their concentration in the solution increases, up to the point where the surface is saturated. Beyond this point an increase in their concentration in the solution produces no effect on their concentration in the surface.

When this stage has been reached the formation of Na_2XCaCl_4, if it takes place in the surface, will not be affected by an increase in the concentration of the salts in the solution. It will, however, be affected by changes in the relative proportions of the salts. The number of molecules in a unit of surface will remain nearly constant, but if the proportion of NaCl in the solution be increased some of the $CaCl_2$ in the surface will be displaced by NaCl.

Below the saturation point the relative proportions of the salts will be of less importance than their total concentration: this is the case at low concentrations in the region of the so-called "nutritive effects."

It is evident that if we adopt this theory we can see why the most favorable proportion must remain approximately the same in spite of variations in concentration, and we thus arrive at a satisfactory explanation of Weber's law.

There are other ways in which permeability appears to be connected with stimulation. One of these has to do with anesthesia. Typical anesthetics decrease permeability. This accords with the idea that stimulation depends on the movement of ions in the tissue. Such movement would be checked by decrease of permeability.

Another has to do with mechanical stimulation. It is well known that the effects of certain kinds of stimuli can be referred directly to chemical changes which they produce in the protoplasm, but there are other kinds which appear to operate by physical means only. In the latter category are such stimuli as contact, mechanical shock and gravitation. While their action appears at first sight to be purely mechanical, they are able to produce effects so much like those of chemical stimuli that it appears probable that in every case their action must involve chemical changes.

The chief difficulty which confronts a theory of mechanical stimulation appears to be this: How can purely physical alterations in the protoplasm give rise to chemical changes? It would seem that a satisfactory solution of this problem might serve to bring all kinds of stimulation under a common point of view, by showing that a stimulus acts in every case by the production of chemical reactions.

An answer to this question is suggested by some observations on the cells of the marine alga *Griffithsia*. When one of the larger cells is placed under the microscope and touched near one end a change occurs in the chromatophores directly beneath the spot which is touched. The surfaces of the chromatophores in this region become per-

meable to the red pigment, which begins to diffuse out into the surrounding protoplasm. This change begins soon after the cell is touched. As the red pigment diffuses through the protoplasm it soon reaches neighboring chromatophores and it may be seen that their surfaces also become permeable and their pigments begin to diffuse out. In this way a wave—which may be compared to a wave of stimulation—progresses along the cell until the opposite end is reached.

The rate of propagation of this wave corresponds to that of the diffusion of the pigment. It would seem that at the point where the cell is touched, pigment, and probably other substances, are set free, diffuse out and set up secondary changes as they progress. These changes are doubtless chemical in nature.

The important question then arises: How does the contact initiate the outward diffusion of the pigment or other substances? It would seem that this may be due to a mechanical rupture of the surface layer of the chromatophores which is either not repaired at all or only very slowly. Many cases are known in which the surface layers of protoplasmic structures behave in this way. If, therefore, such structures exist within the cell, it is evident that any deformation of the protoplasm which is sufficient to rupture their surface layers will permit their contents to diffuse out into the surrounding protoplasm. A great variety of cellular structures (plastids, vacuoles, "microsomes," inclusions, etc.), possess surface layers of great delicacy and it is easy to see how some of these may be ruptured by even the slightest mechanical disturbance.

If these processes occur it is evident that purely physical alterations in the protoplasm can give rise to chemical changes. Responses to contact and mechanical stimuli may be thus explained; and since gravitational stimuli involve deformation of the protoplasm we may extend this conception to geotropism.

Further studies, which are now being made, can not be mentioned for lack of time, but it is hoped that what has been said may suffice to indicate how stimulation, vitality, injury and recovery, together with permeability and antagonism, may be brought under a common point of view and perhaps traced to similar fundamental causes.

W. J. V. OSTERHOUT

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JOHN MUIR[1]

IT is as a human being ever striving upward that I would portray John Muir.

From his early boyhood to his old age this spirit dominated him. As a child in Scotland, at every opportunity, in spite of parental prohibitions, and notwithstanding the certainty of punishment upon his return, he would steal away to the green fields and the seashore, eagerly interested in everything alive.

Illustrating this trait, I quote his boyhood impressions of the skylarks:[2]

> Oftentimes on a broad meadow near Dunbar we stood for hours enjoying their marvelous singing and soaring. From the grass where the nest was hidden the male would suddenly rise, as straight as if shot up, to a height of perhaps thirty or forty feet, and, sustaining himself with rapid wing-beats, pour down the most delicious melody, sweet and clear and strong, overflowing all bounds, then suddenly he would soar higher again and again, ever higher and higher, soaring and singing until lost to sight even in perfectly clear days, and oftentimes in cloudy weather "far in the downy cloud" . . . and still the music came pouring down to us in glorious profusion, from a height far above our vision, requiring marvelous power of

[1] Address delivered upon the occasion of the unveiling of a bronze bust by the sculptor C. S. Pietro, at the University of Wisconsin, December 6, 1916.

[2] "The Story of My Boyhood and Youth," John Muir (Houghton-Mifflin Co., 1913), pp. 46 and 47.

wing and marvelous power of voice, for that rich, delicious, soft, and yet clear music was distinctly heard long after the bird was out of sight.

At the age of eleven Muir with his father came to America to a farm beside a lake a few miles from Portage. His interest in the life of the wilderness, new to him, was thrilling. When first on Fountain Lake meadow he saw the lightning bugs, he thought to himself[3]

that the whole wonderful fairy show must be in my eyes; for only in fighting, when my eyes were struck, had I ever seen anything in the least like it. But when I asked my brother if he saw anything strange in the meadow, he said: "Yes, it's all covered with shaky fire-sparks." Then I guessed it might be something, outside of us.

Again when first he heard partridge drumming he thought,[4]

It must be made by some strange disturbance in my head or stomach, but as all seemed serene within, I asked David whether he heard anything queer. "Yes," he said, "I hear something saying boomp, boomp, boomp, and I'm wondering at it." Then I was half satisfied that the source of the mysterious sound must be in something outside of us, coming perhaps from the ground or from some ghost or bogie or woodland fairy.

Every boy who has grown up in Wisconsin and has a tinge of the love of nature will appreciate how accurately does John Muir tell of the feelings inspired in the heart of the lad, after the long cold winter, by the first migrating birds and the early spring flowers. The robin and the bluebird declare that spring is approaching, and the pasque flower shouts that spring has arrived.

Muir became intimately familiar with the southern Wisconsin flowers. He knew the gorgeous white water lily, the deliciously perfumed, delicate lady's slipper, white, pink and yellow, the scarlet painted cup, the nodding trillium and all the other beautiful early spring flowers so dear to the Wisconsin country children.

The life of the boy on the farm in pioneer days was one of hard work, and that of Muir was exceptionally hard; but he differed from the majority of his fellows in that he was not content simply to become a plowboy. Notwithstanding the prolonged physical labor, his inner spirit expressed itself, in the summer by his love of out of doors, and in the winter by study and mechanical invention.

After leaving school in Scotland at the age of eleven, Muir had little further opportunity as a boy for formal instruction. He succeeded, however, in persuading his father to get for him a higher arithmetic; and in the ends of the afternoons and in the evenings after the day's work he mastered the book; he followed this by algebra, geometry and trigonometry.

From the neighbors, and in various ways, he possessed himself of Scott's novels and the volumes of a number of the poets, including Shakespeare and Milton; and also he read the "Pilgrim's Progress," Josephus and similar works.

In the winter, immediately after prayers, he was required to go to bed; but the elder Muir, one night in repeating the order added, "If you *will* read, get up in the morning and read. You may get up in the morning as early as you like." From that time throughout the winter Muir was up at one o'clock. Although his father protested, he was held to his promise. In this manner Muir gained five hours each day, the time being used partly with his books and partly in the mechanical inventions in which he became interested—thermometers, barometers, hygrometers, pyrometers and clocks.

His more complicated clock told not only the hour of the day, but the day of the week and the month, and also had attachments which upturned his bedstead, setting him on his feet at the required hour in the morning, and other attachments to start the fire or light the lamp.

The ingenuity which young Muir displayed in mechanical construction, had he followed this talent, undoubtedly would have given him a great career as an inventor. But such a life would never have satisfied his inner impulses.

Hearing of a state fair at Madison, Muir

[3] "The Story of My Boyhood and Youth," p. 71.
[4] *Ibid.*, p. 72.

was encouraged to exhibit his various contrivances there. The extraordinary merit of his work was at once recognized, and the instruments exhibited attracted much attention. It was his visit to the fair that drew him to the university.

At Madison, Muir worked at any sort of thing, earning a few dollars. Of this he said:[5]

I was thus winning my bread while hoping that something would turn up that might enable me to make money enough to enter the state university. This was my ambition, and it never wavered, no matter what I was doing. No university, it seemed to me, could be more admirably situated, and as I sauntered about it, charmed with its fine lawns and trees and beautiful lakes, and saw the students going and coming with their books, and occasionally practising with a theodolite in measuring distances, I thought that if I could only join them it would be the greatest joy of life. I was desperately hungry and thirsty for knowledge and willing to endure anything to get it.

Of his admission to the university he says:[6]

With fear and trembling, overladen with ignorance, I called upon Professor Sterling, the dean of the faculty, who was then acting president, presented my case, and told him how far I had got on with my studies at home, and that I hadn't been to school since leaving Scotland at the age of eleven years, excepting one short term of a couple of months at a district school, because I could not be spared from the farm work. After hearing my story, the kind professor welcomed me to the glorious university—next, it seemed to me, to the Kingdom of Heaven. After a few weeks in the preparatory department I entered the freshman class.

Doing odd jobs during the term and working in the harvest fields in the summer, Muir maintained himself at the university for four years; but pursued those studies toward which he was attracted rather than a regular course. He was interested in all the sciences, and particularly in botany and geology. It was in his botanical studies about these Madison lakes that he first learned to wander. Upon leaving the university Muir says:[7]

From the top of a hill on the north side of Lake Mendota I gained a last wistful, lingering view of the beautiful university grounds and buildings where I had spent so many hungry and happy and hopeful days. There with streaming eyes I bade my blessed Alma Mater farewell. But I was only leaving one university for another, the Wisconsin University for the University of the Wilderness.

John Muir's life work was that of an explorer and a student of nature. His travels, beginning in the region of the Great Lakes shortly after leaving the university, extended throughout the world, and continued to old age. His journeys carried him to Russia, Siberia, Africa, Australia, South America, and other remote regions little visited by the ordinary traveler. But his contributions to knowledge were mainly due to his studies in California and Alaska.

It was inevitable that after reaching California Muir should be drawn by an irresistible attraction to the Sierra Nevada. His first visit filled him with burning enthusiasm; and during some ten years he studied the flora, the fauna, the glaciers, and the topography of that superb range. His study of animals and plants was not that of systematic biology—the interior structures or methods of life growth—indeed was very unlike that in the biological laboratories of the present day. His interests were rather in the habits of the plants and animals and their relations to their neighbors and to their environment. Each animal or plant as an individual was a subject of interest to John Muir. The mighty silver firs, the sugar pines, the Douglas spruces and the gigantic sequoia were ever inspiring him; and he never ceased to write of their beauty and their majesty. However, he was no less moved by the dwarf cedars, pines and oaks, which near the timber line carried on a brave struggle through the years against the terrific storms and prolonged cold of the heights.

The wonderful variety and beauty of the flowers of the Sierra also deeply stirred him. With enthusiasm he sought and admired each species, whether found for the first time or an old friend.

The animals and their habits thrilled him with delight. There have been no more ap-

[5] *Ibid.*, p. 274.

[6] *Ibid.*, pp. 275–76.

[7] "My Boyhood and Youth," pp. 286–287.

preciative nature studies ever written than that of the cheery, dauntless songster, the water-ouzel and that of the lively, demonstrative, and pugnacious Douglas squirrel. In short, his study of plants and animals was an appreciation of them as objects of nature, such as have been made by only two other Americans, John Burroughs and Henry Thoreau; and Muir worked on a far larger scale than either. He was one of the great interpreters of nature.

Muir's interpretation of plant and animal life is always humanistic without being false or sentimental, as has been too frequently true of the modern nature writers. The rigid scientific man reads his descriptions with pleasure; and, while they are clothed with human warmth, he finds them in accord with strict truth.

But John Muir's most profound emotion was aroused by magnificent scenery, and this he always saw in its relations to sky and cloud.

The Sierra Nevada he thus epitomizes:[8]

Along the eastern margin of the Great Valley of California rises the mighty Sierra, miles in height, reposing like a smooth, cumulus cloud in the sunny sky, and so gloriously colored, and so luminous, it seemed to be not clothed with light, but wholly composed of it, like the wall of some celestial city. Along the top, and extending a good way down, you see a pale, pearl-gray belt of snow; and below it a belt of blue and dark purple, marking the extension of the forests; and along the base of the range a broad belt of rose-purple and yellow, where lie the miner's goldfields and the foothill gardens. All these colored belts, blending smoothly, make a wall of light ineffably fine, and as beautiful as a rainbow, yet firm as adamant.

It seemed to me the Sierra should be called not the Nevada, or Snowy Range, but the Range of Light. And after ten years spent in the heart of it, rejoicing and wondering, bathing in its glorious floods of light, seeing the sunbursts of morning among the icy peaks, the noonday radiance on the trees and rocks and snow, the flush of the alpenglow, and a thousand dashing waterfalls with their marvelous abundance of irised spray, it still seems to me above all others the Range of Light, the most divinely beautiful of all the mountain-chains I have ever seen.

Muir's explorations of the Sierra brought to the public as never before the wonders of its river-worn ravines, its enormous glacier-cut canyons, its mighty cliffs, and its craggy peaks. From the fiery, dusty foothills to the white granite, snow-covered crests, he knew the Sierra as an intimate friend; and through his vivid writings he communicated his glow to all admirers of the sublime in nature.

After years of climbing in the Sierra, the magnificence of Alaska attracted Muir, and four times he visited that region. His explorations there represent the most important part of his geographic work; they added much to the knowledge of the Alaskan coast. A number of important inlets were mapped, the chiefest of which is Glacier Bay. In the latter was discovered the majestic glacier which bears Muir's name, a mighty stream of ice, in its broadest part twenty-five miles wide and having two hundred glacial tributaries. As compared with this, the greatest of the Alpine glaciers is a pigmy.

Muir's close observations upon the motion and work of glaciers, first the small ones of the Sierra, and later the mighty ones of Alaska, were important contributions to the knowledge of these great agents of erosion.

Muir saw that the mountains of the Sierra and Alaska, while apparently immutable and unalterable, are now being shaped by the same processes that formed them. Storms which drove the ordinary human being indoors were an ardent invitation to John Muir. Of one of the storms of the Sierra he writes:[9]

It was easy to see that only a small part of the rain reached the ground in the form of drops. Most of it was thrashed into dusty spray, like that into which small waterfalls are divided when they dash on shelving rocks. Never have I seen water coming from the sky in denser or more passionate streams. The wind chased the spray forward in choking drifts, and compelled me again and again to seek shelter in the dell copses and back of large trees to rest and catch my breath. Wherever I went, on ridges or in hollows, enthusiastic water

[8] "The Mountains of California," John Muir (The Century Co.), pp. 4–5.

[9] "The Mountains of California," John Muir, pp. 262–63.

still flashed and gurgled about my ankles, recalling a wild winter flood in Yosemite when a hundred waterfalls came booming and chanting together and filled the grand valley with a sealike roar.

After drifting an hour or two in the lower woods, I set out for the summit of a hill 900 feet high, with a view to getting as near the heart of the storm as possible. In order to reach it I had to cross Dry Creek, a tributary of the Yuba that goes crawling along the base of the hill on the northwest. It was now a booming river as large as the Tuolumne at ordinary stages, its current brown with mining-mud, washed down from many a "claim," and mottled with sluice-boxes, fence-rails, and logs that had long lain above its reach. A slim footbridge stretched across it, now scarcely above the swollen current. Here I was glad to linger, gazing and listening, while the storm was in its richest mood—the gray rain-flood above, the brown river-flood beneath. The language of the river was scarcely less enchanting than that of the wind and rain; the sublime overboom of the main bouncing exultant current, the swash and gurgle of the eddies, the keen dash and clash of heavy waves breaking against rocks, and the smooth, downy hush of shallow currents feeling their way through the willow thickets of the margin. And amid all this varied throng of sounds I heard the smothered bumping and rumbling of boulders on the bottom as they were shoving and rolling forward against one another in a wild rush, after having lain still for probably 100 years or more.

It is at the time of storm that the large work of erosion is done. The great storm of the year may do more work than all the other storms of the year; and possibly the great storm of the century more work than all the other storms of the century.

John Muir's explorations of the Sierra and in Alaska were done alone. He had no pack train; his entire outfit he carried on his back, a sack of bread and a package of tea for food (as long as they lasted), his scientific instruments and his note book constituted his load; he had neither rod nor gun, usually no blanket, and seldom a tent except when chance threw him in with others.

This means to those who have been in the mountains and on the glaciers that Muir was wet for days and nights, that throughout many nights he was cold, that he was frequently hungry; yet to these discomforts, which would be intolerable to a less hardy man, Muir appeared oblivious.

Climbing in the mountains by one's self, as did Muir, is one of the most exacting of the physical arts. The semiprofessional climbers, who climb in order to write articles for magazines, go with not less than two professional guides, the three being roped together. Only those who have *done* climbing will appreciate how unlike are the two methods. When three are roped together, if one makes a mistake, in all probability his life is saved. When a man is climbing alone on a steep or vertical cliff, his first mistake is likely to be his last. Neither hand nor foot can be moved except with the exercise of sure judgment, and with the nicest precision.

Muir was able to do what he did only by possessing a most wonderful combination of clear eye, unfaltering nerve, and limbs of great strength and endurance. John Muir's books, in the matter of personal safety, are in marked contrast with those of many mountain climbers. One finds danger only occasionally mentioned. In order to appreciate Muir's marvelous, almost uncanny skill as a climber, it is necessary to go to the writings of others who have had the good fortune to see Muir at work. With remarkable speed, unflagging energy, and nerves unshaken, he would climb on dangerous ground for twelve, fourteen or sixteen hours without rest; and on one remarkable occasion when a life was at stake his mountain work extended throughout the night, during which he had not only himself to guide, but to lead and carry his crippled friend over very difficult ground in the darkness.

The same qualities were shown in Muir's glacial work. To explore glaciers alone, and especially unknown glaciers, requires great agility and endurance, constant skill, steady coolness, and never-failing watchfulness. To jump innumerable crevasses, to cross those too wide to jump on ice bridges, are a severe strain upon the nerves of any man; and yet Muir, on one of his trips of exploration, dragging a heavily loaded sled over the rough ice or pushing it ahead of him across the ice

bridges, worked day after day alone on the vast glacier that bears his name.

The man who goes out to the wilds alone is a true lover of nature, not a lip worshiper. The mighty forests are sometimes so soundless that the ear hears only the circulating blood; at other times are a tumultuous mass of tossing boughs, swaying limbs and crashing trunks. In the impenetrable darkness of the forests at night, it is as if the eye did not exist; but the tense ear may catch a myriad mingled sounds—the moaning of the trees, the falling of the waters, and the joyful, weird, or angry cries of fowl and beast. In the day the eye may sweep over the endless plain, leap a hundred miles to the distant mountain peak, or attempt to penetrate the gray mist hanging over the crevasses of the glaciers. To be alone with nature, oppressive and terrifying to the city born, was a delicious pleasure to Muir. Indeed it was with almost delirious joy that he felt himself to be a part of the handiwork of the Almighty. To him cliff, air, cloud, flower, tree, bird and beast—all were manifestations of a unifying God.

The great public service of John Muir was leading the nation through his writings to appreciate the grandeur of our mountains and the beauty and variety of their plant and animal life, and the consequent necessity for holding forever as a heritage for all the people the most precious of these great scenic areas. Probably to his leadership more than to that of any other man is due the adoption of the policy of national parks.

Of a man who is likable, it is a commonplace to say that all who knew him loved him; but this was so intensely true of Muir that one feels he should have a stronger word than love. For his friends, mingled with love, were ardent admiration for his tall, thin, sinewy frame, and almost worship for the inner fire which burned upon his strong and noble face.

The story of Stickeen reveals the adorable qualities of the man as well as the finer qualities of a dog. Here are the impressions of his companion, the missionary Young, to whom Muir told the story of Stickeen after that memorable day and evening upon Taylor Glacier:[10]

> Finally Muir broke the silence. "Yon's a brave doggie," he said. Stickeen, who could not yet be induced to eat, responded by a glance of one eye and a feeble pounding of the blanket with his heavy tail.
>
> Then Muir began to talk, and little by little, between sips of coffee, the story of the day was unfolded. Soon memories crowded for utterance, and I listened till midnight, entranced by a succession of vivid descriptions the like of which I have never heard before or since. The fierce music and grandeur of the storm, the expanse of ice with its bewildering crevasses, its mysterious contortions, its solemn voices were made to live before me.
>
> When Muir described his marooning on the narrow island of ice surrounded by fathomless crevasses, with a knife-edged sliver curving deeply "like the cable of a suspension bridge" diagonally across it as the only means of escape, I shuddered at his peril. I held my breath as he told of the terrible risks he ran as he cut his steps down the wall of ice to the bridge's end, knocked off the sharp edge of the sliver, hitched across inch by inch and climbed the still more difficult ascent on the other side.
>
> But when he told of Stickeen's cries of despair at being left on the other side of the crevasse, of his heroic determination at last to do or die, of his careful progress across the sliver as he braced himself against the gusts and dug his little claws into the ice, and of his passionate revulsion to the heights of exultation when, intoxicated by his escape, he became a living whirlwind of joy, flashing about in mad gyrations, shouting and screaming "Saved, saved!" the tears streamed down my face.

It was especially fitting that, in recognition of Muir's great public service to conservation through advancing the movement for the creation of forest reserves and national parks, the University of Wisconsin, many years after his regretful farewell, granted him her highest academic honor, the degree of doctor of laws.

It is indeed fortunate and most appropriate that through the decades and centuries to come, the youth of the university may behold this beautiful bronze bust which has so faithfully caught the thoughtful countenance of Muir, as if in meditation upon the meaning of the

[10] "Alaska Days with John Muir," S. Hall Young, pp. 187–88.

order of the universe—which so prolifically creates, which so lavishly destroys, and which through innumerable alternations of life and death in some mysterious way ever climbs to higher things.

CHARLES R. VAN HISE

SCIENTIFIC EVENTS

SCHOOL OF THE GENERAL EDUCATION BOARD

DR. OTIS W. CALDWELL, now head of the department of natural sciences in the school of education of the University of Chicago, has been appointed director of a new elementary and secondary school to be established by the General Education Board in connection with Teachers College, Columbia University. The general management will be vested in an administrative committee composed of James E. Russell, dean of Teachers College; Dr. Caldwell, V. Everit Macy, Mrs. Willard D. Straight, Felix M. Warburg, Arthur Turnbull, George E. Vincent, Wickliffe Rose, Charles P. Howland and Abraham Flexner, subject to the authority of Columbia University and Teachers College. The plans contemplate discarding Latin and Greek, which will be replaced in the curriculum by modern languages, French, German and Spanish. Science is to have a more prominent place than in the ordinary school. The school is understood to be planned to carry out the ideas set forth in Dr. Abraham Flexner's essay "The Modern School." The announcement given out by the General Education Board says:

> Organized recreation, play and games will be provided for. Constant efforts will be made by means of individual, class and school excursions, by means of pictures, lantern slides, charts, maps, shop and laboratory, special reading matter, and discussions to give the pupils sufficient contact with their natural, industrial, social, economic, vocational and domestic environment so as to derive the basis for their school work from real situations, and thus make school work constantly real to them. The school will frankly discard that theory of education known as "formal discipline," and will undertake to secure training through the careful and thorough study of subjects which are in themselves valuable. It is believed that a much more effective discipline can be thus secured.

The new school, which will open with part of its classes in the fall of 1917, will admit boys and girls from 6 years of age up. It is stated that tuition fees will be moderate and that there will be free and partly free scholarships.

THE EDWARD L. TRUDEAU FOUNDATION FOR RESEARCH AND TEACHING IN TUBERCULOSIS

AN endowment fund has been created as a memorial to the late Dr. Edward L. Trudeau, to perpetuate his name and to continue the scientific investigations that were a life-long interest of the American pioneer in tuberculosis research. The income is to be devoted to the following purposes:

> 1. To maintain laboratories and carry on research into the nature, causes and treatment of tuberculosis.
>
> 2. To maintain regular courses of instruction for physicians and others in the most advanced knowledge of the above subject, under the name of the Trudeau School of Tuberculosis.
>
> 3. To offer young physicians the opportunity to engage in research work, while undergoing treatment for the disease, through the establishment of fellowships.

The trustees of the Trudeau Sanatorium are to administer this fund, with the aid of an advisory council of distinguished investigators and teachers, consisting of Professor William H. Welch and Professor Theodore C. Janeway, of Johns Hopkins University; Dr. Hermann M. Biggs, New York State commissioner of health; Dr. William H. Park, director of laboratories, New York City Health Department; Professor Theobald Smith, director of the department of animal pathology, Rockefeller Institute; Professor Warfield T. Longcope, Columbia University; Professor Thomas McCrae, Jefferson Medical College, Philadelphia, Pa.; Dr. John H. Lowman, Western Reserve University, Cleveland, O., and Dr. Vincent Y. Bowditch, of Boston.

The plans for researches in tuberculosis are comprehensive in their scope, including the fields of clinical and laboratory experimentation. The scientific study and treatment of this disease under conditions favorable for the continued observation of patients with the best facilities obtainable, will be encouraged in

every way. Clinical and laboratory work will be carried on under experienced direction, with the aim of enlisting the interest of physicians and others in the solution of many problems awaiting study.

The facilities for research are as follows:

1. The Trudeau Sanatorium Medical Department (150 beds), including the Infirmary.
   (a) The Clinical Laboratory.
   (b) The Research Laboratory.
   (c) The X-Ray Laboratory.
   (d) The Statistical Department.
2. The Saranac Laboratory. (In the village of Saranac Lake.)
3. By cooperation with the various tuberculosis sanatoria and hospitals in the vicinity, clinical and laboratory facilities are available in the following institutions:
   (a) The State Sanatorium, Ray Brook, 350 beds.
   (b) The Stony Wold Sanatorium, 150 beds.
   (c) The Gabriels Sanatorium, 70 beds.
   (d) The Reception Hospital, 20 beds.
   (e) The Saint Mary's Hospital, 20 beds.

AWARDS AND PRIZES OF THE PARIS ACADEMY OF SCIENCES

THE committee, as we learn from *Nature*, has had to examine thirteen requests for grants from the Bonaparte Fund. The following grants are recommended: (1) Charles Alluard (4,000 francs), for continuing the publication, in conjunction with R. Jeannel, of the scientific results of three expeditions in eastern Africa (1903 to 1912). (2) M. Bondroit (2,000 francs), for collecting the material in France necessary for the constitution of a fauna of French ants. (3) Pierre Lesage (2,500 francs), for the continuation of his experiments on the plants of the coast zone, and in particular his researches on the transmissibility of the characters acquired by plants watered with salt water. (4) The Touring Club de France (3,000 francs), to contribute to the establishment of the new botanic garden at Lautarel (Hautes-Alpes). (5) Camille Sauvageau (3,000 francs), for extending to the species of *Laminaria* of the Mediterranean and the Channel the remarkable discoveries of the author on the development of a single species which grows in the Bay of Biscay. (6) Em. Vigoroux (2,000 francs), to contribute to the purchase of apparatus useful for the continuation of his interesting researches on the state of silicon dissolved in metals. (7) Raoul Bayeux (2,000 francs), to aid him in continuing his researches on the physiological effects and the therapeutics of hypodermic injections of gaseous oxygen. The author proposes to study experimentally the action of hypodermic oxygenation on the defensive reactions of the organism against asphyxia and against infections. (8) Joseph Laïs as a contribution to the expense of photogravures relating to the photographic chart of the heavens, the copper-plates to become the property of the Paris Observatory.

The committee has in reserve, after payment of these grants, 55,000 francs.

Among prizes awarded by the academy were the following:

The Jean Reynaud prize to the late Henri Amagat, for the whole of his work; the Baron de Joest prize to Ernest Esclangon, for his researches on the sound phenomena produced by cannon and projectiles; the Houllevigue prize to Edmond Bordage, for his studies on the fauna and flora of Réunion; the Henri de Parville prize to Auguste Barbey (1,000 francs), Louis Raveneau (500 francs), Daniel Bellet (500 francs), and E. Montoriol (500 francs); the Lonchampt prize to Mlle. Thérèse Robert (2,500 francs), for her researches on the function of calcium salts on the growth of plants, and H. Busquet (1,500 francs), for his physiological and pharmaco-dynamical researches; the Wilde prize to M. Mansuy (2,000 francs) and F. Garrigou (2,000 francs), for the whole of their work; the Camére prize to M. Freyssinet, for his novel applications of reinforced concrete; the Gustave Roux prize to (the late) Michel Longchambon (2,000 francs), for his geological and petrographical work; the Thorlet prize to Adolphe Richard; the Lannelongue foundation between Mmes. Cusco and Rück; the Laplace and Rivot prize is not awarded; the Trémont foundation (1,000 francs) to Charles Frément, for his work on the deformations of metals submitted to stresses: the Gegner foundation to A. Claude

(2,000 francs) and Mlle. I. Iotevko (2,000 francs); the Jérôme Ponti foundation to MM. Battandier and Trabut, for their botanical work in northern Africa.

SCIENTIFIC NOTES AND NEWS

THE French Association for the Advancement of Science, in order to fulfil the provisions of its constitution, held a general assembly at Paris on October 28, when the president, M. Emile Picard, made an address, in which he discussed German and French contributions to science.

SIR ROBERT HADFIELD has been elected president of the Faraday Society, London.

DR. ELLSWORTH HUNTINGTON, of Milton, Mass., has been elected president, and Professor John W. Harshberger, of the University of Pennsylvania, vice-president of the Ecological Society of America.

AT the meeting of the Society of Directors of Physical Education and Colleges, held in New York on December 29, Dr. Joseph E. Raycroft, Princeton, N. J., was elected president.

THE New York State Science Teachers' Association, in convention at Syracuse, chose Professor R. C. Gibbs, of the department of physics of Cornell University, as its president.

DR. BARTON WARREN EVERMANN, director of the Museum of the California Academy of Sciences, has been elected president of the Cooper Ornithological Club.

PROFESSOR ROLLA CLINTON CARPENTER, of Sibley College, Cornell University, has resigned, his resignation to take effect at the end of this academic year. Professor Carpenter will reach the age of sixty-five on June 26, 1917, the day before commencement.

THE National Institute of Social Sciences has awarded medals of the society to Professor M. I. Pupin, of Columbia University, for his work in mathematical physics and electrical engineering; to Surgeon General William C. Gorgas, for his work in stamping out yellow fever in Cuba and Panama, and to Dr. George W. Crile, of Cleveland, for his contributions to surgery and allied sciences.

THE C. M. Warren Committee of the American Academy of Arts and Sciences has made an additional grant of $150 to Professor R. F. Brunel, of Bryn Mawr College, for the continuation of his research on the relation between the constitution of aliphatic radicals and their chemical affinities.

HENRY N. OGDEN, professor of sanitary engineering in the college of civil engineering of Cornell University, has been reappointed a member of the State Public Health Council by Governor Whitman. Professor Ogden was made a member of this council when it was created in 1913. Before that he had been for seven years engineer to the state board of health.

THE Bureau of Fisheries has engaged the services of Dr. N. L. Gardner, of the University of California, for comprehensive investigations of the marine algæ of the Pacific coast, with reference to their more adequate utilization and their relation to fisheries.

PROFESSOR HENRI A. HUS, of the department of biology of the University of Michigan, who was granted a three years' leave of absence for the purpose of doing some experimental work for the United States Rubber Company at their plantation in Sumatra and in the botanical garden at Buitenzorg on the island of Java, has returned to the United States owing to lack of laboratory equipment due to the present war, and will continue his work in the New York Botanical Garden.

WE learn from *Nature* that Mr. F. A. Stockdale, director of agriculture, Mauritius, has been appointed by the British Secretary of State for the Colonies director of agriculture, Ceylon, and Dr. H. A. Tempany, government chemist and superintendent of agriculture for the Leeward Islands, has been appointed to succeed Mr. F. A. Stockdale as director of agriculture, Mauritius.

ON December 25, Dr. Charles L. Parsons, chief chemist of the Bureau of Mines, returned from a ten-weeks' trip in Europe. As a representative of the War Department, Dr. Parsons visited Norway, Sweden, England, France and Italy, to make a study of nitrogen

fixation processes. He was offered unusual opportunities for studying the chemical industries, especially those whose development has resulted from the European war. He also visited the clay deposits and the tin and tin concentration works at Cornwall, England.

Professor Vernon L. Kellogg, of Stanford University, continues his work of overseeing the feeding of the Belgian people for another six months. This gives him a year and a half of this work as first assistant to his Stanford colleague, Herbert Clark Hoover.

Dr. G. H. A. Clowes, director of the Gratwick Research Laboratory, spoke on "Colloidal Equilibrium" at the meeting of the Indiana Section of the American Chemical Society on December 8. Dr. Wilder D. Bancroft will address the Indiana Section on March 9, and Dr. E. V. McCollum on May 11.

Dr. Ira N. Hollis, president of the American Society of Mechanical Engineers, visited the University of Illinois last week, to give an address to the faculty and students in the college of engineering, on the subject of "The Relation of Efficiency to Democracy."

Professor Douglas W. Johnson, of Columbia University, addressed the American Philosophical Society on January 5, on the subject, "The Strategic Geography of the Balkan Campaign."

The death has occurred at his home in New Rochelle, N. Y., of Henry Gordon Stott, past president of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers. He was born in the Orkney Islands in 1866.

Roberdeau Buchannan, computer in the U. S. Naval Observatory from 1879 to 1910, the author of works on mathematics, astronomy and genealogy, died on December 18, at the age of seventy-seven years.

The Rev. Brother Chrysostom (Joseph J. Conlen), professor of philosophy and psychology at Manhattan College, died on January 24, aged fifty-four years.

Mr. Juan J. Rodriguez, of Guatemala City, Guatemala, died on December 22, aged seventy-five years. Mr. Rodriguez for many years studied and collected the fauna of Guatemala, and was well known to naturalists as the discoverer of many new and interesting species.

Mr. William Marriot, for forty-three years assistant secretary of the British Meteorological Society and for thirty years editor of the *Meteorological Record,* died on December 28, at the age of sixty-eight years.

Sir Edward Burnett Tylor, Hon. D.C.L., M.A., formerly keeper of the Oxford University Museum, professor and reader in anthropology and professor emeritus, died at Wellington, Somerset, on January 2.

Captain F. C. Selous, known for his zoological explorations in Africa, has been killed in action in East Africa, aged sixty-five years.

Sir E. B. Tylor, professor emeritus of anthropology in the University of Oxford, distinguished for his publications in ethnology, died on January 2, at the age of eighty-four years.

Dr. J. Little, Regius professor of physic, Dublin University, has died in his eightieth year.

Dr. B. R. Poppius, the Finnish entomologist, died on November 27 at the age of forty years.

UNIVERSITY AND EDUCATIONAL NEWS

A bill has been introduced into the state legislature of Arkansas providing a half-mill tax for the University of Arkansas. The bill has been recommended by the trustees of the university and approved by the governor.

Two industrial fellowships for the chemistry of indiarubber have been established in the University of Akron, provided by the Goodyear Tire and Rubber Company and the Firestone Tire and Rubber Company. These fellowships are of the value of $300, and the holder may subsequently enter the employ of the company.

The building of the Hunterian Laboratory of the Johns Hopkins Medical School, completed at the cost of $115,000, has now been opened. According to the *Journal* of the American Medical Association, the building is connected by tunnels with the medical school and

the physiological building. On the first floor are the medical library and the department of art as applied to medicine. Work at the laboratory is directed by a committee of professors and instructors of the medical school. Dr. Milton C. Winternitz is chairman of the committee, and has a laboratory on the fourth floor. The second floor has been leased to the Carnegie Embryological Institute. The third floor will be devoted to work in clinical medicine and children's diseases and the fourth floor to the pathological department.

DISCUSSION AND CORRESPONDENCE

NOTICE OF POSSIBLE SUSPENSION OF THE RULES OF NOMENCLATURE IN THE CASES OF HOLOTHURIA 1758 VS. PHYSALIA 1801, AND BOHADSCHIA 1833 VS. HOLOTHURIA 1791

In accordance with the requirements prescribed by the International Congress of Zoology, notice to the zoological profession is hereby given that on or about October 1, 1917, the undersigned proposes to recommend to the International Commission on Zoological Nomenclature that the rules be suspended in the following cases:

Holothuria Linn., 1758 (type *physalis*), *vs.* *Physalia* Lamarck, 1801 (type *pelagica*). The effect of suspension will be to retain *Physalia* as generic name for the Portugese man of war.

Bohadschia Jaeger, 1833, *vs.* *Holothuria* Bruguière, 1791. The effect of the suspension will be to retain *Holothuria* for the sea cucumbers.

The motion for suspension includes the following points:

1. Suspend the rules in the case of the generic names in question;
2. Permanently reject *Holothuria* 1758, type *physalis;*
3. Validate *Physalia* 1801, type *pelagica* (syn. *physalis* 1758);
4. Accept *Holothuria* as dating from Bruguière, 1791, despite the existence of *Holothuria* 1758 (if rejected);
5. Said suspension is not to be construed as invalidating any specific name.

The grounds advanced for suspension will be:

(*a*) A strict application of the rules in these cases will result in greater confusion than uniformity, because

(*b*) The cases involve a transfer of generic names, almost universally accepted in the sense given above since 1791 (for *Holothuria*) and since 1801 (for *Physalia*), to genera in other groups in connection with which they have been used by only a very few authors during more than 100 years.

The undersigned cordially invites zoologists to communicate, not later than September 1, 1917, to him or to any other member of the commission, either their approval or disapproval of the proposed action.

C. W. Stiles,
Secretary to Commission

DO THE FOWLER'S TOAD AND THE AMERICAN TOAD INTERBREED?

Noting a communication under "Discussion and Correspondence" on pages 463 and 464, of the September 29, 1916, issue of Science, as regards the song of *Bufo fowleri* Putn., I would say that in over fifteen years of experience as observer and student of Amphibians, I have never been able *positively* to trace the clear, trilled song, lasting from 10 to 30 seconds, to any but the American toad, *Bufo americanus* Le Conte. In any large collection of both species, where both occur together, there are individuals which seem to combine the external characteristics of both species. In the study collection of the American Museum of Natural History, New York City, there are, for instance, a number of toads which at first glance would be identified as *Bufo americanus.* They have the large kidney-shaped parotoids, divergent cranial crests, spotted belly of *B. americanus,* but also the short, abrupt profile, proportionally narrow head, and much finer texture of skin, especially that of the belly, of *B. fowleri.* The color pattern alone can not always be relied upon, as *B. americanus* often has the narrow median pale line, the distinct black spots arranged in longitudinal rows, sometimes confluent, and the peculiar greenish gray ground color, of *B. fowleri,* and vice versa, *B. fowleri* has sometimes the reddish brown ground color, with indistinct vertebral streak and but few

scattered black spots and spotted undersides of *B. americanus*. All this, in conjunction with Mr. H. A. Allard's notes and observations, would lead one to believe that both species are closely related, and that they possibly interbreed occasionally, these forms with the characteristic marks, etc., of both species representing the hybrids.

In conclusion I will state that the typical *B. americanus* and the typical *B. fowleri* differ in the following characters, based on examination of hundreds of specimens, covering a period of ten or more years:

Bufo americanus Le Conte

1. Head broad, profile sloping towards tip of snout.
2. Cranial crests always diverging from the nostrils.
3. Skin covered with comparatively large round warts, often arranged in rows or groups, the former on the back, the latter on hind limbs. The undersides are more or less granular. The larger warts often have spiny tips, especially in large females.
4. The legs are stout, and moderately long, the foot large and thick, the fingers rather short and thick.

Bufo fowleri Putnam

1. Head narrow, very thick, profile abruptly rounded towards the tip of the snout.
2. Cranial crests sometimes parallel, often fused in the midline, forming a distinct lump between the eyes. This never occurs in *B. americanus*.
3. Skin finely granular above, with groups of larger warts. These warts are *never* spiny in this species. The under sides are either very finely granular or entirely smooth.
4. The legs are longer, in proportion to the body, than of *B. americanus*, the foot is rather delicate, fingers and toes are long and slender.

Richard Deckert

N. Y. Zoological Park,
New York City

THE POPULAR NAMES OF NORTH AMERICAN PLANTS

To the Editor of Science: In the course of our work here, considerable numbers of plants are frequently sent in by teachers to be named, and doubtless many similar requests for information are received by the officers of the provincial governments and the experiment stations throughout the United States. In replying to such enquiries the Latin name of the species is always given and the English name where such exists. It is clear, however, that pupils in the public schools, as well as many of their teachers, do not and can not reasonably be expected to take any interest in or to remember the Latin names of plants. This being so, it is highly desirable that every species of plant inhabiting the United States or Canada should have an English name. It is further desirable that the name should not be a local one, but should be applicable to the plant wherever it is found, from the Atlantic to the Pacific ocean. If possible, the name should be such as to distinguish the plant from allied species, the name being based on some structural character such as height, hairiness, color of flowers, etc.; or on the habitat, such as marsh, mountain, wood, etc.; or on its use in the service of man, Indian names when such exist being adopted.

Where different genera have the same English name, some qualifying word will be specially necessary. For example, fireweed may mean either *Erechtites hieracifolia* Raf., or *Epilobium angustifolium* L. This ambiguity would be removed by calling the former white fireweed and the latter purple fireweed.

In order that each species of plant may have an English name, it would be necessary to draw up a list of the species inhabiting the United States and Canada, and it seems to the present writer that in drawing up such a list a very wide interpretation should be given to the meaning of the term species. At the present rate of progress, it will be many years before the "North American Flora"—the standard work on the subject for this continent—will be completed, and discussion as to the limits of so-called species may be expected to continue for a much longer period. Consequently, a provisional list should be issued, no attempt being made to define the limits of a species in too critical a manner, the popular English names not being suited for such fine distinctions. The common English name should be applied to aggregate rather than segregate species. For example, pipsissewa or prince's

pine should be regarded as applicable to either *Chimaphila corymbosa* Pursh., or *C. occidentalis* Rydb., the two species into which *C. umbellata* Nutt. has been split up in the "North American Flora."

There is, of course, room for discussion as to the best method of procedure to adopt. Many botanists—especially those who are never called on to name plants for the general public—are quite satisfied with the Latin names alone, and from them in all probability no assistance can be expected in devising English names. The subject is one that might well be discussed at some conference of American botanists, as it mainly concerns ourselves alone.

J. ADAMS

CENTRAL EXPERIMENTAL FARM,
OTTAWA, CANADA,
November 21, 1916

PROPULSION BY SURFACE TENSION

TO THE EDITOR OF SCIENCE: In November, 1911, I described in your columns a little motor boat which I supposed to be novel. A wooden boat only a couple of inches long, was provided with a stern consisting of a slab of soap, and when placed on clean still water moved about with noticeable rapidity.

I have just learned that M. Henri Devaux constructed an absolutely equivalent craft many years ago (*La Nature*, April 21, 1888). His boat was made of tinfoil and the "propeller" was a scrap of camphor attached to the stern.

Pray allow me to tender to M. Devaux my apologies and compliments.

GEORGE F. BECKER

SCIENTIFIC BOOKS

A Sylow Factor Table of the First Twelve Thousand Numbers. By HENRY WALTER STAGER. Carnegie Institution of Washington, 1916. Pp. xii + 119.

Dr. Stager's tables are intended to furnish the possible number of Sylow subgroups for all groups whose order does not exceed 12,000. For every number within that limit are listed all the divisors which are of the form $p(kp+1)$, where p is a prime greater than 2 and k is greater than zero. In determining the possible number of Sylow subgroups such divisors must be known before further methods are applicable. Thus from the table we learn that 1,080 is divisible by $3(1\times 3+1)$, $3(3\times 3+1)$, $3(13\times 3+1)$, $5(1\times 5+1)$, $5(7\times 5+1)$ and $5(43\times 5+1)$. From these results we know that for a group of order 1,080 there may be 1, 4, 10 or 40 subgroups of order 3^3 and 1, 6, 36 or 286 subgroups of order 5. The exact number is to be determined by other principles of group theory. The table also gives the expression of each number up to that limit as products of powers of primes.

The making of tables, a tedious and apparently mechanical task, is of the highest importance in all branches of science. It is likely that more fundamental theorems have been discovered by the examination of listed results than by any other means. This is certainly true in the theory of numbers, and it is possible that workers in the theory of groups have not made enough use of this method of investigation. The construction of tables for the theory of groups is especially difficult on account of the great complexity of the material. Only brief tables have hitherto been undertaken and it is to be hoped that Dr. Stager's work in this direction may be the beginning of a systematic campaign in this important field.

The construction of an extensive table almost always brings to light hidden relations, suggesting new theorems for investigation. In Dr. Stager's table certain numbers are noted which have no divisors of the sort indicated above. Such numbers seem to resemble primes in many ways, and in particular their "curve of frequency" seems to run roughly parallel to the corresponding curve for primes. Dr. Stager has made a study of these numbers, and has added a list of them up to the limit of his table.

The author is to be congratulated upon the completion of so important and formidable a piece of work. While the reviewer has, of course, not checked over any part of the table he has the utmost confidence in the accuracy of the list. The printing has been done by the

photographic methods employed by the Carnegie Institution in the publication of the Factor Tables and the List of Primes. Both the author and the publishers deserve the gratitude of every lover of science in putting in the hands of mathematicians results of such permanent value. D. N. Lehmer

University of California

Feeding the Family. By Mary Swartz Rose. New York: The Macmillan Company, 1916. Pp. xvii + 449, illustrated.

Many factors contribute to the welcome such a book as this will doubtless receive. World conditions are forcing a searching analysis of food supplies. Any discussion of the subject, however, whether for the purpose of conserving existing supplies by reducing waste or of increasing the supply by stimulating production, must be based on an understanding of the relation between food materials and bodily needs, for the food requirement of 10,000,000 families is but a simple multiple of the food requirement of one family. There is a growing disposition, too, among those who set for themselves serious tasks in life to be restive under small ailments which curtail working hours and reduce efficiency. There is a demand, therefore, for a working knowledge of personal hygiene, including simple, rational, well-founded rules for eating. At the same time great new avenues for instruction are opening and home economics, including the subject of foods, is being introduced in places undreamed of a few years ago. It has been made part of the instruction in universities and primary schools and is being taught in remote mountain regions by extension methods and in crowded city tenements by visiting housekeepers. This is creating a demand among instructors for reliable handbooks. At the same time it is creating a great body of intelligent housekeepers in private homes and in public institutions who are ready and anxious to make those fine adjustments between food supplies and family needs without which nation-wide or world-wide campaigns for the conservation of food must be largely ineffective.

Those who approach the subject most intelligently often find that they must use one language—that of calories and protein—in discussing bodily needs, and another—that of bread and butter, or bacon and eggs—in planning meals or in buying food. Only the fortunate few who, of course, include the writer of the book, use both languages with equal facility. Most people need two-part dictionaries of food, by means of which they can change from the language of calories and protein to the language of bread and butter, and back again, if necessary. Such dictionaries are, to be sure, not entirely new. Many books have given 100-calorie portions in terms of common food materials and have recorded in convenient form the food values of many common dishes. Years ago Mrs. Richards put much of this material into chart form for use in the kitchen. The time, however, was not ripe then for such information and the plans were never much elaborated. Now to meet new needs Mrs. Rose has presented a large number of carefully worked-out tables, the fruit of years of study and of teaching. By use of them the reader finds not only the weight, but also the volume, of common foods that it requires to furnish a definite amount of nourishment. We find, for example, not only that it requires $2\frac{1}{2}$ ounces of creamed salt codfish, made after a recipe given in the book, to provide 100 calories of energy and that 32 of the calories would be supplied by protein, but also, what is of even greater value to the housekeeper, that this amount would measure about one-half of a cup. Again we find that a familiar recipe for cottage pudding would make two loaves, 6 by 4 by $1\frac{3}{4}$ inches in size; that it would weigh 24.3 ounces; that it would supply 2,100 calories; and that a 100-calorie portion would be a slice $1\frac{3}{4}$ by 2 by $2\frac{1}{2}$ inches in size. In general, every provision is made for adjusting food supply to food requirement.

The food requirements of persons of different ages and occupation are carefully presented, and family dietaries are worked out.

The subject of prices is subordinated to that of food values. This is fortunate, for food values are permanent while prices fluctuate

with seasons or years or markets. It is often necessary for the sake of clearness of presentation to deal with prices, but the general futility of doing so is demonstrated by the fact that even at the moment when this book was published prices differed widely from those reported in the chapters on the cost of food. This shows the need of thorough education in food values and we might almost say of training in arithmetic, which will enable one to see the money relations of food for oneself and to compare costs as prices change.

The important but often neglected subject of food prejudices is most happily treated in "Food for Children Eight to Twelve Years Old."

As Mrs. Rose points out, "only a few well-chosen dishes need be offered at any one meal, but a tendency to choose a single dish for a meal and refuse everything else should be discouraged. In adult life a well-balanced diet demands more kinds of food than in childhood, when such a variety of elements is supplied by milk alone, and it is a great advantage to have been so trained as to be able to take these in all sorts of forms. Most adults eat in groups and pronounced individual likes and dislikes have great economic and social, if not always physiological, disadvantages. Half the problems of the food provider arise, not from the difficulty of securing wholesome food to make a well-balanced ration, but from the necessity of remembering that . . . [individual tastes vary]. Youth is the time to cultivate respect for all natural foods as a means to physical and mental efficiency, and not merely as ticklers of the palate. . . . Most food aversions are acquired in early life when the sensibilities are keenest. An accident at the table with humiliating consequences, an unpleasant association of a food with illness, a comparison with something disagreeable, may cause repugnance lasting for years. Such aversions, once acquired, call for patience and tact and may never be completely overcome. . . . It is worth while to take thought as to how to keep children's attitude toward their food rational."

C. F. LANGWORTHY

RECENT PROGRESS IN PALEONTOLOGY

Invertebrates.—Owing to disturbed international conditions, the number of foreign contributions to the literature of paleontology is almost negligible. In this country the most important work on the invertebrate division of the science is contained in the two volumes on the Upper Cretaceous of Maryland, published by the geological survey of that state. It is illustrated by a handsome series of plates.

Dr. C. D. Walcott, in continuation of his studies of Cambrian geology and paleontology, has published the third of a series of papers that bears the title of "Cambrian Trilobites" (*Smithson. Misc. Coll.*, Pub. No. 2420). It is accompanied by 23 excellent plates. In the *Proceedings of the U. S. National Museum* Professor T. D. A. Cockerell has two papers on American and British fossil insects. In Bulletin 96 of the same institution Dr. R. S. Bassler and Ferdinand Canu have published a "Synopsis of American Early Tertiary Cheilostome Bryozoa." Dr. A. F. Foerste is author of an important memoir on the Upper Ordovician formations in Ontario and Quebec, published by the Canadian Geological Survey. Some new Silurian brachiopods from Maine are made known by H. S. Williams, and new Oligocene mollusks from Georgia are described by W. H. Dall, both papers contained in the *Proceedings of the U. S. National Museum.*

Fishes.—Some new anatomical features regarding the peculiar arthrodiran genus *Homosteus* are described by Dr. A. S. Woodward in the *Journal of the Torquay Natural History Society.* New investigations on British Paleozoic ganoids and lung-fishes have been conducted by Dr. D. M. S. Watson and Henry Day (*Mem. and Proc. Manchester Lit. and Phil. Soc.*, Vol. 60, pt. 1), and the latter author has also issued a note on the parasphenoid of a Palæoniscid (*Ann. Mag. Nat. Hist.*, Vol. 16, pp. 421–434).

The remarkable spirally coiled dental organs of *Helicoprion,* from the Permian of Russia, form the subject of two communications by A. Karpinsky, the original discoverer of these re-

mains. A new species, *H. clerci*, is described by him from the Artinsk beds. The reference of this genus to the Cestraciont group of sharks seems now fully warranted. Dr. A. S. Woodward (*Nature*, Vol. 98, pp. 163–164) has also discovered evidence which substantiates the view that the segmented structures known as *Edestus* form the symphysial series of the dentition belonging to *Campodus*- or *Orodus*-like sharks.

Italian science suffered an irreparable loss in the death last April of Professor Francesco Bassani, of Naples. A fine tribute to his memory, with a list of his numerous papers on fossil fishes and other subjects, has recently been published by his colleague Geremia D'Erasmo, and another by G. de Lorenzo.

Comparatively little has been added to our knowledge of fossil fishes from North America during the year. Dr. L. M. Lambe has described a few ganoids from the strata of Lower Triassic age near Banff, Alberta (*Trans. Roy. Soc. Canada*, Vol. 10), and others from the Coal Measures of Linton, Ohio, have been investigated by L. Hussakof (*Bull. Amer. Mus. Nat. Hist.*, Vol. 35). A report upon the collection of fossil fishes contained in the U. S. National Museum has recently been published by C. R. Eastman (*Proc. U. S. Nat. Mus.*, Vol. 52). It includes descriptions of a number of new species.

An indispensable reference work which brings together the titles of all publications on the subject of fishes, living and fossil, including their anatomy, physiology, embryology and systematic relationships, is the newly published Bibliography of Fishes, by Dr. Bashford Dean. The collection of the titles for the authors' volume of this work is the result of twenty-five years' unremitting labor. [C. R. E.]

Amphibians and Reptiles.—Dr. R. S. Moodie's important monograph[1] on the Coal Measures Amphibia of North America adequately summarizes and illustrates the numerous and highly varied types of the oldest well-known land-living vertebrates, which are first foreshadowed by a single footprint from the Upper Devonian of Pennsylvania. The amphibians of the Carboniferous age were mostly swamp-living forms embracing small newt-like and serpentiform types; there were also larger animals related to the Labyrinthodonts of succeeding ages.

The amphibians and reptiles of the "Red Beds" of Texas, New Mexico and elsewhere are very fully discussed in a monograph by Professor E. C. Case.[2] After describing the geography and environments of Permo-Carboniferous times the author gives an extended analysis of the fauna, in which he discusses the food supply and food habits, as well as the terrestrial and aquatic adaptations, of these animals. A majority of the forms were partly aquatic and more or less raptorial and carnivorous, but some fed upon insects, others upon mollusks, and others to some extent upon plants. The author discusses the conflict between the defensively and offensively armed types and shows that many of the amphibians and reptiles were so overspecialized that they became extinct at the end of this period. Two of the reptilian families and one type of amphibians developed excessively long spines on the back which the author believes to have been useless to these animals. He suggests that owing to the abundance of the food supply and to the perfection of the weapons of offense, the surplus vitality thus generated was used in the continued elaboration of certain structures, which were possibly useful in their inception, but finally became elements of weakness, and led to the extinction of the group. The monograph is accompanied by many restorations of these animals, by full faunal lists and by a welcome discussion of the classification.

Professor S. W. Williston also continues his investigations of American Permian vertebrates.[3] He gives first a full description of the skull of *Pantylus*, a cotylosaurian reptile which retains a very primitive skull-pattern, and secondly an invaluable and well-illustrated synopsis of the whole fauna of Permian amphibians and reptiles. These forms con-

[1] Carnegie Inst., Washington, 1916, Pub. No. 238.

[2] Carnegie Inst., Washington, 1915, Pub. No. 207.

[3] *Contr. Walker Museum*, Vol. 1, No. 9, pp. 165–236. Chicago, 1916.

tinue to yield many facts of great morphological interest. For example, the author holds that the almost universally accepted view of the origin of the sternum or breast-bone from the fusion of the distal and ventral ends of dorsal ribs in the mid-line is quite incorrect and that the conditions in the early vertebrates prove conclusively that the sternum has been derived rather through the fusion of the "ventral ribs," or gastralia, which were not cartilaginous, but dermal bones, arranged originally in many rows of small rhomboidal ossicles.

Morphological interest is also predominant in Mr. D. M. S. Watson's description[4] of the brain-case in *Eryops* and other Permian types which had an extremely low and primitive type of brain and inner ear. New Permian amphibians and reptiles of South Africa are described in a series of papers from the Transvaal Museum by Dr. Van Hoepen,[5] and from the South African Museum by Mr. S. H. Haughton.[6] The amphibians include most of the groups found also in the Permian of North America. *Myriodon* and *Rhinesuchus,* which are allied to the American *Eryops,* are represented by nearly complete skeletons.

Lieutenant R. Broom continues his description[7] of South African Triassic amphibian specimens in the British Museum. He also describes several new anomodont reptiles.

Two thecodont reptiles of South Africa are described, respectively, by Dr. Van Hoepen[8] and Mr. Haughton.[9] Of these *Sphenosuchus* is a primitive reptile remotely allied to the ancestors of the Phytosaurs, Dinosaurs and other reptiles with two temporal arches.

Several new Phytosaurs of the Trias of Texas and adjoining states are described by M. G. Mehl.[10] Of these long-snouted, gavial-like forms, *Machæroprosopus* and *Angistirhinus* are represented by very good skulls. The same author has discovered an ancestor of the South American caiman in the Oligocene of South Dakota.[11]

Among the sauropod dinosaurs, Dr. Holland[12] has briefly described a new species, *Apatosarus louisæ,* discovered in the great quarry near Jensen, Utah, from which the Carnegie Museum has recovered a very important series of dinosaur skeletons.

Mr. Barnum Brown continues his descriptions[13] of the varied dinosaur fauna of the Cretaceous of Alberta, describing several new types of duck-bill dinosaurs, one of which is ancestral to the crested dinosaur *Saurolophus.* The same author describes a remarkably well-preserved skeleton of another crested dinosaur which had a high skull crest resembling that of a cassowary. Some notes on the marine Triassic reptilian fauna of Spitzbergen are contributed by Carl Wiman in a paper recently published by the University of California.[14] [W. K. G.]

Birds.—A preliminary notice of a nearly complete skeleton of a gigantic fossil bird allied to *Diatryma* from the Lower Eocene is contributed by W. D. Matthew to the *American Museum Journal* for November of this year. It was a contemporary of the well-known four-toed horse *Eohippus* and comes from the same formation in Wyoming. It equalled the moas of New Zealand in bulk, but had a gigantic head with enormous compressed beak like the South American fossil bird *Phororhachos.* A further description of this remarkable creature, together with its probable relations to other extinct avian groups, was presented by Dr. Matthew and Mr. Granger before the December meeting of the Paleontological Society.

Dr. R. W. Shufeldt has reviewed our knowledge of the primitive Eocene genus *Gallinuloides,* and describes a new anserine form,

4 *Bull. Amer. Mus. Nat. Hist.,* Vol. 35, pp. 611–636.

5 *Ann. Transvaal Mus.,* Vol. 5, No. 2, pp. 125–149.

6 *Ann. South African Mus.,* Vol. 12, p. 65.

7 *Proc. Zool. Soc. London,* 1916, pp. 355–368.

8 *Ann. Transvaal Mus.,* Vol. 5, No. 1, p. 83.

9 *Ibid.,* p. 98.

10 *Bull. Univ. Oklahoma,* Ser. 5, pp. 5 and 26; *Jour. Geol.,* Vol. 23, No. 2, Feb.-March.

11 *Jour. Geol.,* Vol. 24, No. 1, Jan.-Feb., p. 47.

12 *Ann. Carnegie Mus.,* Vol. 10, pp. 143–145.

13 *Bull. Amer. Mus. Nat. Hist.,* Vol. 35, pp. 709–716. *Ibid.,* pp. 701–708.

14 *Bull. Dept. Geol.,* Vol. 10, No. 5.

Palæochenöides, from the Miocene of South Carolina.[15] He also contributes an extensive account of fossil birds' eggs.[16] [C. R. E.]

Mammals.—Dr. W. K. Gregory[17] has continued his researches upon the evolution of the Primates. In a preliminary discussion of the theory of trituberculy, he shows that the tritubercular molar is the primitive type for Primates as for other Mammalia, and discusses the origin of this type of tooth. He then reviews critically what is known of fossil Anthropoidea and discusses their relationships to man and to the existing anthropoid apes. The shortening of the face and reduction of the front teeth in man he regards as an adaptation mainly to predaceous habits and a carnivorous diet replacing the primitive fruit-eating adaptation of his anthropoid ancestors. This is necessarily associated with the exclusive use of the hands and of weapons for attacking and dividing the prey, in contrast with the use of the teeth for those purposes among the Carnivora.

In his discussion of the phylogeny Dr. Gregory combats strongly the tendency of several recent authors to carry the divergence between the human and anthropoid stems far back into geologic time. He considers "that the Upper Miocene ancestors of the Hominidæ were at least very closely akin to the Upper Miocene common ancestors of the chimpanzee and gorilla, and that they were in fact heavy-jawed, stout-limbed, tailless and semi-erect anthropoid Catarrhinæ, with quadritubercular second and third upper molars and *Sivapithecus*-like lower molars." Nor does he regard the Neanderthal man as wholly excluded from the direct ancestry of the higher races. Dr. Gregory's paper is a notable contribution to the literature dealing with the ancestry of man.

Of high importance likewise is Stehlin's revision of the Eocene Primates of Europe,[18] now completed. The author gives an extended and well-illustrated description of the genera hitherto known, and adds a number of new forms, the most interesting of which are the Chiromyoidea, resembling the modern aye-aye (*Chiromys*) in the rodent-like front teeth, and in the author's opinion related to this group of lemurs. All of the Primates of the European Eocene are in the lemuroid stage of evolution, but their more exact affinities are regarded as very doubtful.

Dr. George F. Kunz's new book, "Ivory and the Elephant," includes a very full and interesting compilation of what is known concerning fossil proboscideans and the evolutionary history of the order, especially as to recent discoveries and opinions.

The discovery of Eocene Mammalia in Burma by Pilgrim and Cotter[19] is of great interest as affording the first direct evidence upon the early Tertiary Mammalia of Asia. The bulk of the fauna consists of primitive anthracotheres which may well be regarded as representing the ancestral group from which the ruminants are derived. This confirms the forecasts of Stehlin, Matthew and others as to the place of origin of the ruminants.

Mr. H. E. Anthony's discovery of numerous well-preserved fossil mammals in a cave in Porto Rico[20] is of remarkable interest. The fauna thus far found consists of a small ground-sloth related to one of the smaller Cuban genera, two or more new genera of rodents rather distantly related to the South American hystricomorphs, and an insectivore of a wholly new family, very remotely related to the continental forms, and lizards not yet studied. This evidence when carefully weighed will have an important bearing on the geographic relations of Porto Rico to other West Indian islands and to the mainland. As far as appears at present, it indicates a prolonged isolation and the ultimate derivation of the fauna rather from Central America by way

15 *Geol. Mag.*, Vol. 3, August, pp. 343–347.

16 *The Emu*, Vol. 16, pp. 80–91.

17 *Bull. Amer. Mus. Nat. Hist.*, Vol. 35, pp. 239–355.

18 *Abh. Schweiz. Palæont. Gesell.*, 1916, Vol. 41, pp. 1299–1552, 2 pls. and 82 text figs.

19 *Records Geol. Surv. India*, Vol. 47, pp. 42–77, 6 pls.

20 *Annals N. Y. Acad. Sci.*, Vol. 27, pp. 193–203, 7 pls. See also Allen, J. A., *ibid.*, pp. 17–22, 4 pls. Later descriptions covering more extensive material in press at time of writing.

of Cuba than from South America by way of the Lesser Antilles; certainly not from North America. But it seems doubtful whether any former continental connection is indicated, the mammalian fauna, like that of Cuba, etc., being limited to a few groups which can be accounted for in other ways.

Mr. E. L. Troxell[21] describes the skeleton of a Pliocene horse which is in many respects intermediate between the three-toed horses of the Miocene and the true *Equus* of the Pleistocene. It is referred to the genus *Pliohippus*, but is much more complete and more truly intermediate in character than the type species described many years ago by Marsh. A second and more complete skeleton has recently been discovered in western Nebraska; both are in the American Museum in New York. [W. D. M.]

C. R. EASTMAN,
W. K. GREGORY,
W. D. MATTHEW

SPECIAL ARTICLES

THE REFLECTION OF γ-RAYS BY CRYSTALS[1]

RUTHERFORD and Andrade[2] have shown that when γ-rays fall on the faces of crystals at certain angles regular reflection takes place as in the experiments of Bragg[3] with X-rays. This should show itself by an increase of absorption of the γ-rays, and in the experiments to be described evidence has been obtained of this character.

A fine pencil of γ-rays passed through a vessel containing a crystalline substance into an ionization chamber where the ionization was measured. The crystalline structure of the absorber was then destroyed either by powdering, melting or by dissolving in water, and any change in the ionization current was measured by a balance method. The change in the ionization gives a measure of the radiation which is reflected from the crystals at such an angle with the direction of the beam as not to enter the ionization chamber. The experimental arrangement is shown in Fig. 1.

The small thin glass crystallizing dish *D*, containing the crystals under investigation was placed over a hole in the lead block *L* so as to rest either directly on the lead block or on an adjustable iron-gauze shelf above it. The γ-rays from the source *S* passed through the crystals and hole, which was 1.2 cm. in diameter, and through a very thin sheet of aluminum foil into the ionization chamber *A*. The balance chamber *B* also received γ-rays from the source through a thick adjustable lead slit *R*. Electrodes passing into *A* and *B* through earthed guard rings were connected to a Wilson-Kaye electroscope *E*. The chambers *A* and *B* were hollow brass cylinders 15 cm. long and 8 cm. in diameter. They were insulated and connected to -200 volts and $+200$ volts, respectively. By means of the key *K* the gold leaf could be earthed or joined to a divided megohm in series with a storage battery for the purpose of measuring the sensibility of the leaf. The leads to the electroscope from the chambers *A* and *B* were completely shielded by brass tubing and lead foil earth connected, so that electrostatic effects were eliminated. The balance chamber *B* was surrounded by a lead sheet 3 mm. thick to prevent any soft scattered radiation from entering it, and all connections to the electroscope were shielded as much as possible from direct radiation by thick blocks of lead. The lead block *L* was 7.5 cm. thick, and for the position of the source used in most of the experiments about twenty-five times as much ionization was produced by the rays passing through the hole as through the rest of the block.

Owing to their short wave-lengths the angles of reflection for γ-rays are probably small. It is, therefore, necessary to use a small cone of

[21] *Amer. Jour. Sci.*, Vol. 42, pp. 335–348, 7 text figs.

[1] This article was written in April, 1914, and describes some experiments performed in Professor Sir Ernest Rutherford's laboratory at the University of Manchester. At that time Rutherford and Andrade were working on the same problem by the more direct method. While the results recorded in this paper have apparently little quantitative value, the general method of attack may be of sufficient interest to justify their publication.

[2] Rutherford and Andrade, *Phil. Mag.*, May, 1914, p. 854.

[3] Bragg, *Phil. Mag.*, May, 1914, p. 881.

rays from a strong source and to work at high sensibility. The sensibility used in the different experiments was varied between 125 and 50 divisions per volt and was measured after each reading of the electroscope.

With the crystals in position a balance was obtained between the two ionization currents in the two chambers. Any change in absorption would then be shown by a corresponding motion of the leaf of the electroscope. In practise it was found unwise to attempt to adjust the balance very accurately when using strong γ-ray sources, since small fluctuations appeared in the movement of the leaf, possibly due to the Schweidler effect.

EXPERIMENTS WITH POWDERED CRYSTALS

The crystallizing dish was filled with the crystals of a given material and placed as shown in Fig. 1. The lead slit was then adjusted until a small leak was observed in the electroscope and the average of a number of readings taken. The crystals were then reduced to a fine powder in a mortar and this powder pressed down in the dish to produce the same thickness of layer as in crystal form. The leak was then read as before.

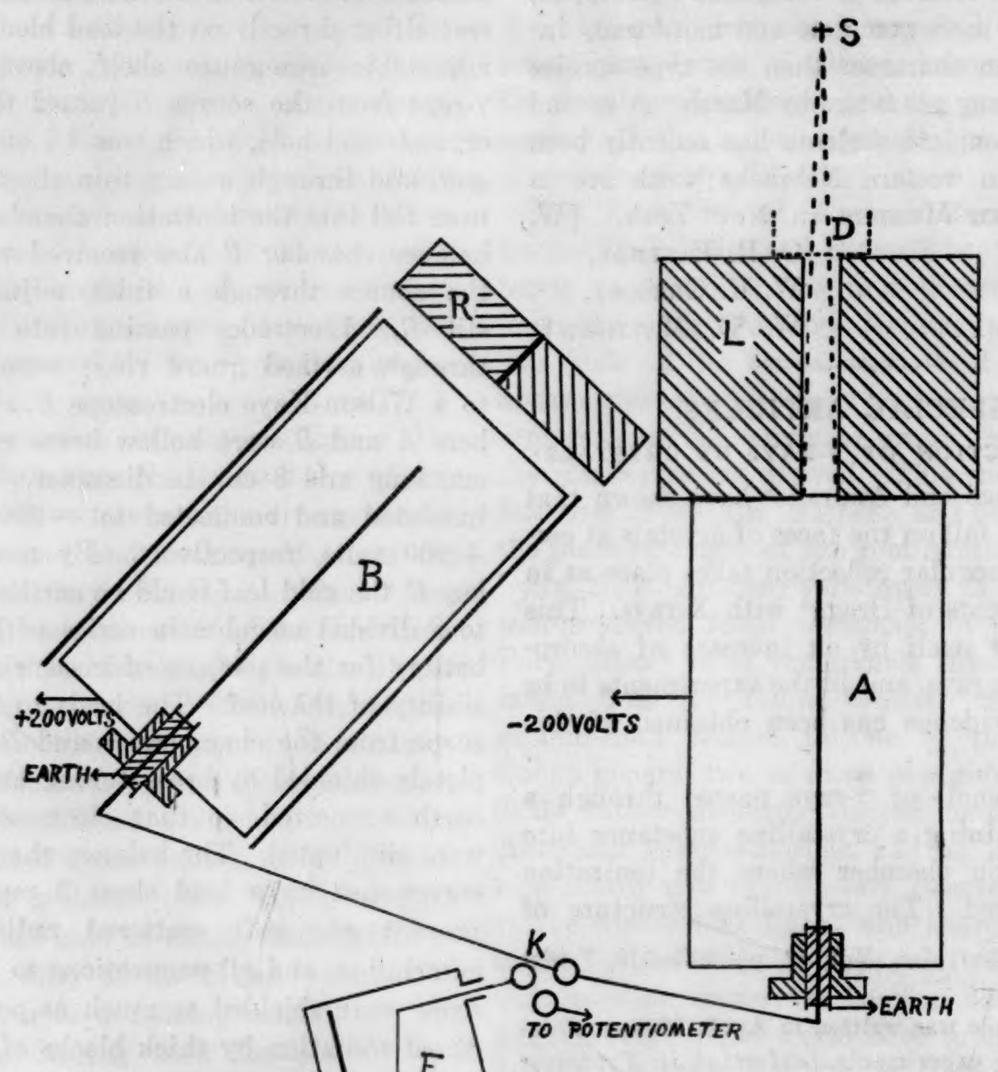

FIG. 1

A decrease in absorption corresponding to a diminution in reflection in general took place. In most of the experiments a 14 mg. radium standard was used as source of γ-rays. A

TABLE I

Position of Crystals	Leak in Div. per Min. Max. Size 1.5 × .5 Cm.	Leak in Div. per Min. Max. Size .5 × .5 Cm.	Leak in Div. per Min. Powdered	Max. Change Due to Absorption	Percentage of Cone Absorbed
On lead block	27.5, 30.4, 31.8, 29.8 } mean 29.9	25.6, 25.5, 25.7 } mean 25.6	20.4, 21.7 } mean 21.1	8.8	2.3
5 cm. above lead block	14.5, 13.5, 13.6 } mean 13.9	12.8, 13.0 } mean 12.9	7.9, 7.7, 7.9 } mean 7.9	6.0	1.5

large number of tests were made using lead nitrate crystals with γ-ray sources varying from 200 to 14 millicuries of radium emanation, the source and crystals being placed at different distances from the chamber A. The sensibility of the electroscope was also varied over a wide range.

Table I. gives a summary of the results obtained for six separate experiments with lead nitrate.

The percentage of total beam absorbed was obtained by dividing the total change in absorption from crystalline to non-crystalline state by the leak due to the entire cone of rays measured by connecting chamber B alone to the electroscope. For the above experiments in which a layer of lead nitrate crystals 3.4 cm. thick was used, with the 14 mg. standard as source of rays, this reading was 415 divisions per min.

TABLE II

Material	Number of Experiments	Weight in Grams.	Thickness of Layer in Cm.	Percentage of Total Beam Absorbed
Lead nitrate	17	250–70.5	3.4–1.2	2.3– .4
Lead acetate	8	196–29.2	3.5– .6	4.8–1.0
Potassium sulphate	4	106	2.5	1.6–1.0
Hydrogen potassium sulphate	2	89	2.5	.6– .4
Potass. dichromate	2	106	2.5	.34–.26
Mercuric bromide	1	124	2.5	1.0
Mercury nitrate	1	163	2.5	1.3

A detailed study of the effect was made using γ-ray sources varying from 200 to 14 millicuries of radium emanation, the source and crystals being placed at different distances from the chamber A. The sensibility of the electroscope was also varied over a wide range.

Table II. gives a summary of results obtained for a number of crystalline materials.

Since the size of the crystals differed greatly and other conditions of experiment were not the same in all cases, it is not possible to attempt any quantitative comparison of these results. They are inserted as an indication of the order of the effects observed.

EXPERIMENTS WITH CRYSTALLINE MERCURY

A more direct method would be to note the relative γ-ray absorption for some substance which could easily be obtained in crystalline and non-crystalline states. Water and mercury satisfy these conditions. Owing to the large density of the latter, it should produce a good deal of γ-ray scattering, and since it melts rapidly the sensibility of the electroscope would not alter appreciably during an experiment. The radiation entering the balance chamber was adjusted so as to give a very slow rate of leak of the electroscope for a given weight of mercury. The mercury was then removed and solidified in a Dewar vessel by the use of carbon-dioxide snow. The rates of leak with the solid mercury were then measured and observations taken as melting proceeded. More than 40 separate tests were made under widely varying experimental conditions, but while the data in general showed a small decrease in absorption for the fluid state, it was in most cases little more than the experimental error. The crystals obtained in every case were very minute.

SOLUTION EXPERIMENTS

A number of attempts were made to note a change in absorption for lead nitrate entering into solution. Other soluble crystalline substances were also tried including salt, sugar, etc. A large crystallizing dish containing 600

c.c. was used nearly filled with water and a uniform layer of medium-sized crystals placed on an iron gauze shelf midway between the bottom and the surface of the water. Any change of absorption was noted as the crystals went into solution. Slight changes took place as the material dissolved and went to the bottom, yet after a thorough stirring when solution was complete the readings of the electroscope returned to almost the initial value. A small decrease in absorption was noted, however, in the majority of the experiments.

It is hoped to repeat these experiments for mercury and solutions, using more refined apparatus and methods, and to study the effect of crystalline structure on reflection by an examination of changes in absorption for substances of high molecular weight which crystallize in two forms such as lead nitrate, mercury perchloride and mercury iodide.

In conclusion I wish to express my indebtedness to Professor Sir Ernest Rutherford for suggesting this general field of research; also to Dr. Ernest Marsden for many helpful ideas.

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SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 561st meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, December 2, 1916, called to order by President Hay at 8 p.m., with 50 persons in attendance.

The following program was rendered:

The Discovery of an Interesting New Tardigrade: W. P. Hay.

Professor Hay gave a brief description of a tardigrade belonging to the genus *Batillipes* discovered by him some years ago at Beaufort, N. C. It is closely related to *B. mirus* Richters but differs from that species in a number of important characters.

The structure and relationship of the tardigrades was discussed and the conclusion was reached that *Batillipes*, in spite of its evident specialization along certain lines, is probably the most primitive genus of the group.

From *Batillipes* through *Halechiniscus* to *Oreella* and *Echiniscus* was suggested as one line of development, while from *Echiniscoides* through *Milnesium* to *Macrobiotus* and *Diphascon* appears to be another. The genus *Tetrakentron* with its single species *T. synaptæ* shows a high degree of specialization due to parasitism and *Microlyda* is probably the larval form of *Halechiniscus*.

Attention was called to the habitat of the bear animalcules belonging to these genera. Five of them, *Batillipes, Halechiniscus, Microlyda, Tetrakentron* and *Echiniscoides* are marine. *Echiniscus* and *Oreella* are strictly terrestrial. *Macrobiotus* is mostly terrestrial or lacustrine but is represented in salt water by at least two species. *Diphascon* is terrestrial and lacustrine.

The fact that the majority of the genera are marine and that this list includes all the more primitive genera points strongly to a marine origin for the group. It also supports the idea advanced by Professor Richters in 1909 that the tardigrades are probably most closely related to the chætopod worms and should be removed from the class Arachnida in, or near, which the group is usually placed in our zoological text-books.

Professor Hay's communication was illustrated by charts and diagrams.

Exhibition of Venezuelan Plants and Fruits: J. N. Rose.

Dr. Rose had on exhibition a large table full of fruits, fruit products and various articles made of parts of Venezuelan plants. He explained their usage and described the plants from which they were obtained. The specimens were obtained for the most part in the vicinity of La Guaira and Caracas. Dr. Rose's communication was discussed by Messrs. H. Pittier, M. W. Lyon, Jr., and others.

Poisonous Snakes: M. W. Lyon, Jr.

Dr. Lyon gave an account of the various specific substances that have been found in snake venoms, and outlined their modes of action on the various tissues of bitten animals. He spoke of the various antiserums that have been prepared against these venoms, and their therapeutic uses. He also called attention to the non-specific treatment of snakebites in the light of modern statistics and experiments. He then gave a brief outline of the classification of venomous snakes, their geographic distribution, of the development and structure of the poison gland and fang. His communication was illustrated by lantern slide views of skulls, glands and fangs of poisonous snakes, of types of poisonous snakes and of some of the histological changes caused by snake venom. This communication was discussed by Messrs. A. A. Doolittle, H. Pittier, H. M. Smith, H. E. Ames and T. E. Wilcox.

M. W. Lyon, Jr.,
Recording Secretary